

Paracondylar process: a rare cause of craniovertebral fusion – a case report

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A 21-year-old female presented to a chiropractic clinic with chronic neck and headache pain. She had an osseous torticollis and abnormal range of neck motion on rotation to the left. Radiographic examination revealed a unilateral paracondylar process of the occiput fusing to the lateral transverse process of the atlas. A paracondylar process is classified as an occipital vertebra. It is an enlarged bony process of the cranial base which projects caudally towards the transverse process of the atlas. She was treated with spinal manipulation below the level of fusion which resulted in a marked decrease in headache and neck pain. The embryology, frequency, radiographic appearance and clinical implications of a paracondylar process are discussed in this paper.
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KEY WORDS: abnormalities; atlas; chiropractic; craniovertebral fusion; occipital vertebra; paracondylar process.

Une jeune femme de 21 ans s'est présentée à une clinique de chiropratique parce qu'elle souffrait de cervicalgie et de céphalée chroniques. Elle avait un torticollis osseux, et l'amplitude des mouvements du cou, lors de rotations vers la gauche, était anormale. Les radiographies ont révélé une fusion d'un tubercule paracondylien unilatéral de l'occiput à l'apophyse transverse latérale de l'atlas. Le tubercule paracondylien est considéré comme une vertèbre occipitale. Il s'agit d'une grosse projection osseuse, sise à la base du crâne, qui est orientée vers l'apophyse transverse de l'atlas. La patiente a été traitée par manipulations de la colonne vertébrale sous le siège de la fusion, et le traitement s'est soldé par une diminution notable de la cervicalgie et des céphalées. Il sera question, sans le présent article, de l'embryologie, de la fréquence, de l'image radiographique et des conséquences cliniques du tubercule paracondylien.
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MOTS CLÉS : anomalies, atlas, chiropratique, fusion crânio-vertébrale, vertèbre occipitale, tubercule paracondylien.

Introduction

The craniovertebral region is an area of the spine with a high level of variability. There are several types of craniovertebral fusion. We present one of those, the paracondylar process (PCP). A PCP is an enlarged bony process of the cranial base which projects caudally toward

the transverse process (TVP) of the atlas. It is considered an incidental finding on radiographic examination. In extreme cases the PCP can fuse to the TVP of the atlas causing functional limitations in neck movement and may cause clinical symptoms due to alterations in posture and restricted range of motion.

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Case report

A 21-year-old female presented to a chiropractic office with chronic headache and neck pain. The pain began insidiously 10 years earlier. The headache pain was an intense dull ache located in the left suboccipital region of the neck radiating into the frontal area. The neck pain was worse in the morning. The headaches would occur 4 to 5 times a week, lasting one to two hours and were relieved by daily tylenol. The patient reported frequently waking up with neck pain. There were no neurological symptoms. She had sought prior medical and chiropractic care with no lasting relief of symptoms. There was no history of prior injury to the neck.

Observation showed an abnormal range of motion on rotation to the left. Her head would move anteriorly as she rotated to the left (Figure 1). Her active range of motion was also restricted and painful in right lateral flexion. Additionally, torticollis was evident with head tilt. Clinical examination revealed palpable tender left suboccipital muscles and a hard bone like mass in the right sub-occipital area. Cervical tenderness and dysfunction was noted at the C2–3 level with tenderness of the right sternocleidomastoid muscle. Neurological examination including cranial nerve testing was unremarkable.

Plain film radiographs revealed a PCP that projected from the occipital bone on the right (Figure 2). The proc-

ess appeared to be located behind the TVP of the atlas. The process was visible on both anteroposterior open mouth (APOM) and lateral views. A stress view demonstrated no evidence of instability at the atlantodental interval but the APOM view demonstrated unequal periodontal interspaces. Computer tomography (CT) stress views in rotation demonstrated no fixed rotatory subluxation. The PCP was shown to be fused to the TVP of the atlas (Figure 3).

Treatment consisted of light spinal manipulation below the level of fusion, trigger point therapy and stretching. The patient went through a course of treatment over a 6 week period. She reported marked improvement from headache pain with only periodic headaches over the next 20 months. After spinal manipulation, she would note an immediate improvement in active right lateral flexion. The recurrences responded well to occasional chiropractic treatment. The patient was also instructed to increase her pillow thickness in an attempt to increase her sleeping comfort. This resulted in the patient reporting a marked reduction in her morning pain.

Discussion

The paracondylar process is considered a type of occipital vertebra. Occipital vertebra include several other anomalies including third condyle, basilar process, accessory bone elements separate or fused to the foramen magnum



Figure 1 Active range of motion in a) left rotation showing anterior head carriage, b) neutral position showing torticollis and c) normal right rotation.

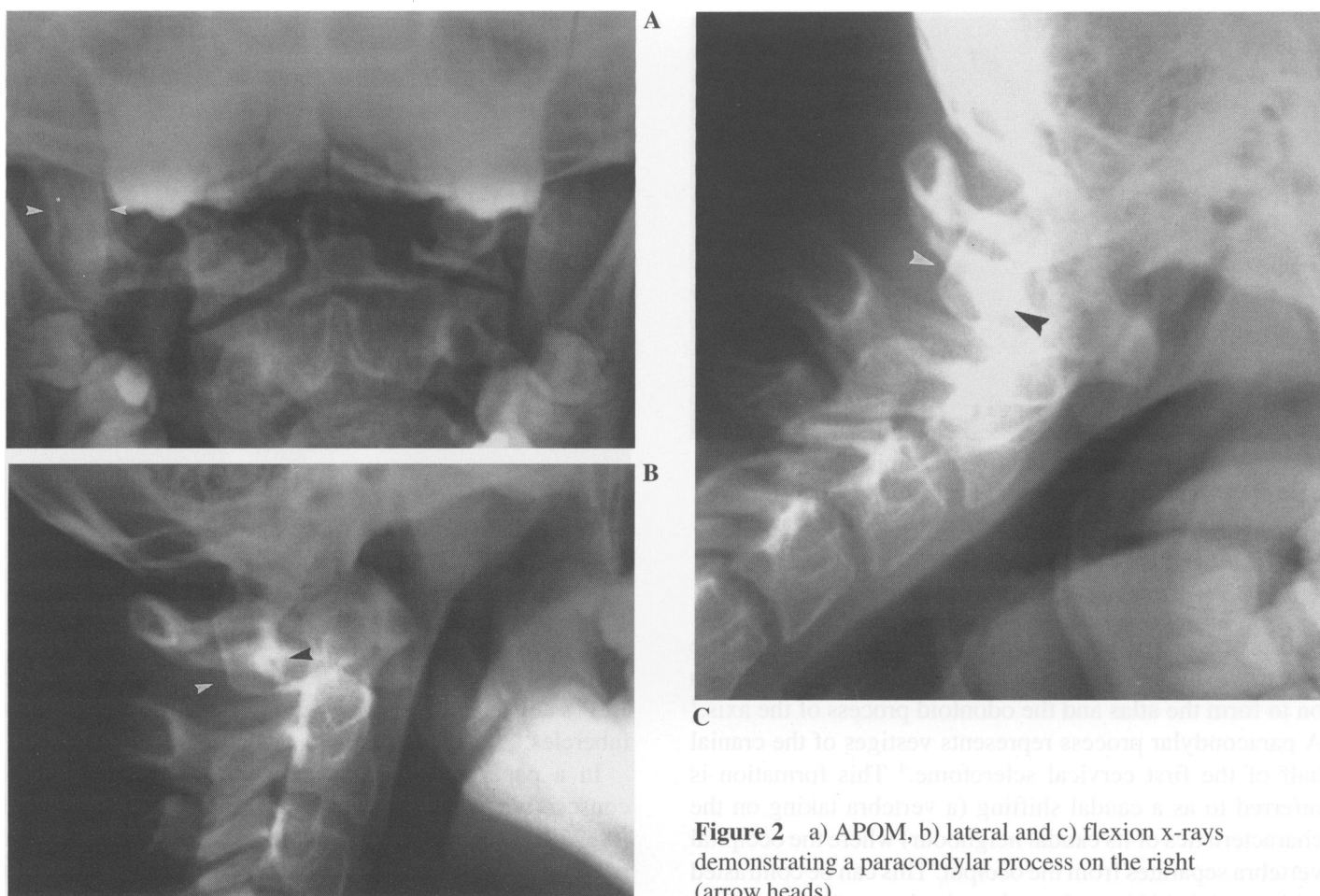


Figure 2 a) APOM, b) lateral and c) flexion x-rays demonstrating a paracondylar process on the right (arrow heads).

and transverse fissures of the basioccipital bone.¹

The PCP has also been called a paramastoid process, paraoccipital process, jugular process and parajugular process.^{2,3} Some authors feel that paramastoid process is an incorrect term and prefer the term paracondylar.^{1,4,5} The PCP is a broad based, cone-shaped osseous mass projecting down from the lateral aspect of the occipital condyle toward the TVP of C1.⁴ The process is in the location of the insertion of the lateral rectus capitis muscle. This muscle can be diminished or absent in the presence of larger processes.²

The PCP can manifest as a number of variations⁶ from a small tubercle to a large bony process forming a synovial joint (Figure 4) or fusing to the TVP of the atlas. The smaller tubercles tend to be bilateral and the larger proc-

esses unilateral.³ The epitransverse process is the mirror image and is attached to the transverse processes of the atlas projecting cephalad toward the occipital condyle.⁴

Embryology

The paracondylar process would have formed from a mal-development of the first cervical sclerotome around the 4th week of development in utero.⁷ The occipital bone is derived from basioccipital, exoccipital and supraoccipital portions which all surround the foramen magnum.⁸ The basiocciput goes on to develop into four occipital somites. The caudal portion of the 4th occipital somite goes on to fuse with the cranial portion of the 1st cervical somite to form the proatlas. The proatlas is assimilated into the occiput to form the articular condyles and the tip of the odon-

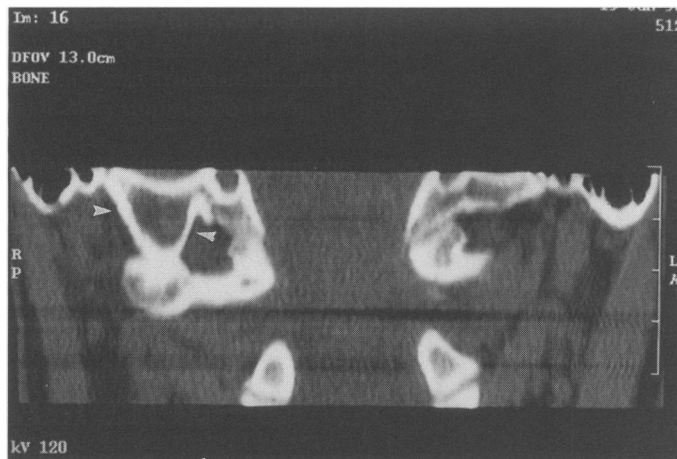


Figure 3 High resolution reformed coronal images of the base of the skull to C2 demonstrating fusion of a PCP (arrow heads) arising from the base of the skull to the right lateral transverse process of C1.

toid process. The caudal half of the 1st cervical somite along with the cranial part of the second cervical somite go on to form the atlas and the odontoid process of the axis.⁷ A paracondylar process represents vestiges of the cranial half of the first cervical sclerotome.⁴ This formation is referred to as a caudal shifting (a vertebra taking on the characteristics of its caudal neighbour) where the occipital vertebra separates from the occiput. This can be contrasted with cranial shifting where the atlas becomes completely fused to the cranial base, which is termed occipitalization of the atlas.⁹ Occipitalization of the atlas has been associated with more severe neurological symptoms and even death.^{8,10}

Frequency

The paracondylar process is considered a rare developmental anomaly with only a few cases reported in the medical literature.⁹ The frequency of this anomaly has been reported in anthropology, x-ray and anatomical studies. The anthropology literature tends to show a high percentage of these traits, as they include small tubercles which would usually not be detected radiologically. Williams³ reports variation in frequency of between 2% and 30% which he feels is population specific. Anderson⁹ examined 1300 skulls from an excavation of St. Gregory's Priory from Medieval Canterbury. Six skulls had evidence of paracondylar tubercles (0.46%) and one skull had a well

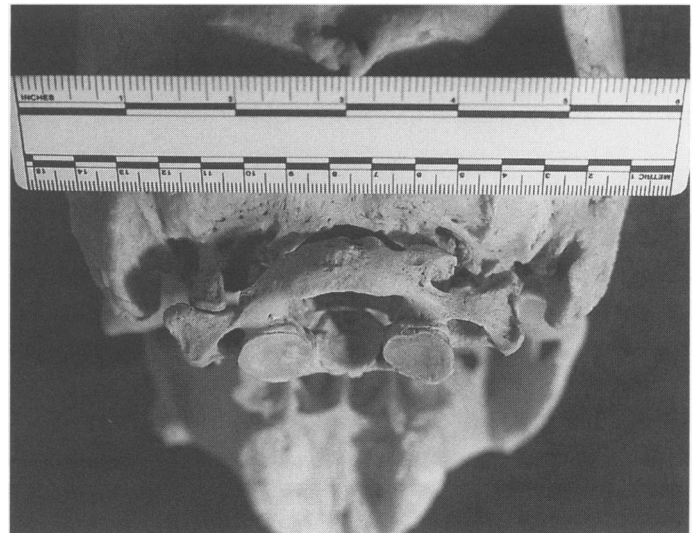


Figure 4 Skull showing paracondylar process articulating with the transverse process of the atlas on the left. With permission Daniel J Wescott, University of Tennessee.

defined PCP (0.077%). The more developed cases of PCP's are generally considered rarer than the more minor tubercles.¹⁰

In a paper based on roentgen examination of 4000 consecutive patients, 5 cases of PCP's were reported (0.125%). The reporting of PCP's in this manner may be reduced by the limited ability of radiographs to detect smaller processes.¹ In an anatomical study by Srisopark only a slightly higher frequency was reported, with 2 cases in 692 specimens (0.29%).⁹

Radiographic appearance

Radiographically a paracondylar process can usually be seen on an APOM view. The mastoid process may obstruct the process on the lateral radiograph,¹¹ although larger processes may be visible. CT scans will help differentiate smaller processes from traumatic changes.⁶ Larger processes may need CT scans to differentiate between fusion or articulation with the TVP of the atlas.¹¹

The paracondylar process usually has a broad base and can be the shape of a cone. The process is bordered by the cortical layer with a center of spongy bone. In rare cases pneumatic cells may be seen in the process which are communicated with those of the mastoid process,^{1,2} although it is felt that this variation has nothing to do with a paracondylar process.¹¹

Clinical Implications

A paracondylar process is generally considered to be of little clinical significance¹ showing up on routine x-ray examination or presenting after trauma.^{6,12} Larger processes, such as the one presented here, can have clinical significance^{11,13} causing symptoms that could present to a chiropractor. When the process is fused to or articulating with the transverse process of the atlas, head movement may be limited or completely blocked. Posturally an osseous torticollis may be seen¹¹ or the head may be forced into an attitude of flexion (caput obstipum).¹

PCP's can produce headache symptoms in the occipital region radiating to the forehead. The symptoms have been reported to be worse in the mornings and aggravated by neck movement to one side. Surgical removal of a PCP articulating with the TVP of the atlas was reported in a 18 year old female with chronic headache pain. Immediate relief of pain was noted after surgery. Similar continuous

headaches returned in this patient 2.5 years after the operation.¹³

PCP's generally do not produce neurological signs and symptoms and have been classified in Table 1 as a minor mesodermal asymptomatic anomaly.¹² Black et al.⁷ discuss a skull from a burial in the 1800's with cranio-vertebral fusion caused by a PCP. In this case the author states that there would be no impairment to the passage of the first cervical spinal nerves or the vertebral arteries that pass over the posterior arch of the atlas. One case report of a PCP where vertebral artery angiography and magnetic resonant imaging were performed found normal appearances with regard to the spinal cord, nerve roots and the artery.¹³ We could not find any case reports of a PCP interfering with the vertebral arteries or cervical nerves, although this has not been studied conclusively. This is in contrast to cases of occipitalization of the atlas where vertebral artery abnormalities can be quite frequent. Bernini

Table 1
Classification of Craniovertebral Anomalies

Minor mesodermal asymptomatic anomalies	arch anomalies of atlas arch anomalies of axis atlanto-occipital articulation anomalies occipital condyle asymmetries occipital vertebrae (including paracondylar process)
Minor ectodermal asymptomatic anomalies	blind dermal sinus intradural fibrous band
Minor mesodermal symptomatic anomalies	occipitalization of atlas odontoid hypoplasia odontoid agenesis os odontoideum congenital atlanto-axial instability basilar impression
Minor ectodermal symptomatic anomalies	syringomyelia of neighbouring cord Chiari type 1 malformation
Major anomalies	Chiari type 2-3 malformation with spinal dysraphism syringomyelia with basilar impression
(after: Erbenig A, Oge H, Congenital malformations of the craniovertebral junction: classification and surgical treatment. Acta Neurochir 1994; 127(3-4): 180-185)	

et al.¹⁴ studied 25 patients with basilar impression (the majority had occipitalization of the atlas) and 100 normal controls, comparing bilateral vertebral artery arteriography. They found that modification of the calibre and ending of the vertebral artery was quite frequent in patients with malformation of the occipitocervical joints.

PCP's can be seen in isolation or found in conjunction with other abnormalities. A case was reported by Nicholson¹⁵ that had associated instability between the first and second cervical segment which was due to other abnormalities that were present. In seven skulls with a PCP, Anderson⁹ noted that, four had an associated bipartition of the hypoglossal canal. Black et al.⁶ reported on a case of craniovertebral fusion of a PCP with the TVP of the atlas and the occipital condyle to the superior articular facet of the atlas both on the left. McRae and Barnum¹⁶ reported on 5 cases of PCP's with assimilation of the anterior arch of the atlas to the lip of the foramen magnum. In four of these cases, slight basilar invagination was seen and three had associated fusion at the C2–3 level. The symptoms reported ranged from asymptomatic to headache, dizziness, neck pain, weakness or ataxia. None of these cases, ages 14 to 39-years-old, had head tilt or pain on neck movement. It is important that any associated anomalies be ruled out, that may co-exist with a PCP.

Fusion and synostosis of a PCP with the lateral transverse process of the atlas may be associated with increased stress at the C1–2 level, creating early signs of degenerative changes in the joint surfaces. Osteophytic spurring has been reported at adjacent joints in cases as young as 14 years of age.⁶ The occipito-odontoid ligaments could be stressed with lateral flexion or rotation which may cause overstretching of the ligament leading to atlantoaxial subluxation.¹⁷ This has been reported in complete assimilation of the lateral masses of the atlas to the occipital condyles associated with C2/3 fusion.^{8,10,18} We were unable to find any case reports of instability associated with a PCP in isolation. The possibility of ligamentous laxity at the C1/2 level must be taken into account by any chiropractor considering spinal manipulation directly below the level of fusion. Yochum and Rowe¹⁹ point out that any spinal manipulation directed at the fusion will not increase joint movement at this level and should not be the goal of treatment.

Atlanto-occipital fusion is considered an absolute contraindication to contact sports such as boxing, wrestling,

football, ice hockey, lacrosse and rugby.²⁰ This would especially apply to cases of complete occipitalization of the atlas to the occiput where eventual neurological symptoms or even death can arise. The PCP fusing to the lateral TVP of the atlas would cause concern with the possibility of developing instability at the C1–2 level with trauma.

Conclusion

Small paracondylar processes may be clinically insignificant and undetectable on x-ray. Larger processes can articulate or even fuse to the lateral transverse process of the atlas. The larger processes can be asymptomatic or manifest clinically with symptoms that could present to a chiropractor's office. These PCP's may be generally detectable on radiographic examination of the neck.

PCP can present in its pure form or can be associated with other abnormalities. Care must be taken to preclude any associated anomalies that could cause instability in the upper cervical spine of these patients. The development of instability from overstretching of the ligaments below the level of fusion may also be a possibility. Since the development of instability at the atlantoaxial region have not been conclusively studied in patients with craniovertebral fusion, the chiropractor must exercise caution when considering spinal manipulation in these patients. Once instability has been ruled out, the judicious use of spinal manipulation may be reasonably included in the treatment of patients presenting with a paracondylar process.

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